Predictive maintenance and vibration monitoring

Condition Monitoring
Reducing plant downtimes, avoiding false alarms

Real Time Vibration Monitoring
Online monitoring: Optimizing processes, increasing product quality

Offline Vibration Analysis
Detailed analysis, parameterization and configuration

Measurement Systems for Industry and Energy
www.iba-ag.com

Area of application

Predictive maintenance and vibration monitoring

Many condition monitoring systems and tools for vibration monitoring and analysis are restricted purely to vibration data. Integrating these tools into the iba process data acquisition creates unique possibilities for reliably monitoring and analyzing processes and states.

Condition Monitoring

Industrial machines and systems must feature high availability to reach maximum productivity. Downtimes – in particular unplanned ones – are therefore to be avoided as far as possible. This is possible even in complex production systems with ibaCMC and ibaCMU.

The combination of vibration measurement with process data creates correlated damage trends, which prevents false alarms and reliably detects wear damage.

Real Time Vibration Monitoring

ibaInSpectra offers all the possibilities for real-time monitoring of vibrations - from the individually adjustable frequency band monitoring, to a self-learning module for monitoring frequency spectra, to the orbit monitoring of shaft motions.

Integrating vibration monitoring into ibaPDA makes it possible to take process influences into account during monitoring and to optimize alerting.

Offline Vibration Analysis

Analysis tools are crucial for being able to make meaningful statements about the state of machines and systems or causes of problematic process vibrations. The integration of vibration analysis into the analysis tool ibaAnalyzer offers entirely new possibilities for examining correlations between processes and vibration behavior.

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Condition Monitoring

Reducing plant downtimes, avoiding false alarms

The Condition Monitoring solution by iba, with the Condition Monitoring Center ibaCMC and the Condition Monitoring Unit ibaCMU-S, offers powerful functions for monitoring wear on machines and process-induced vibrations as well as the possibility to correlate the data with each other.

In the Condition Monitoring Unit, so called snapshots of the vibration data and the simultaneously acquired process data are recorded. The damage indicators, calculated from the snapshots are displayed in ibaCMC as long-term trend and are monitored for exceeded limit values.

The derived values are called “virtual trends”. The quality of the loss trend is improved considerably with this process and maintenance measures can be planned reliably.

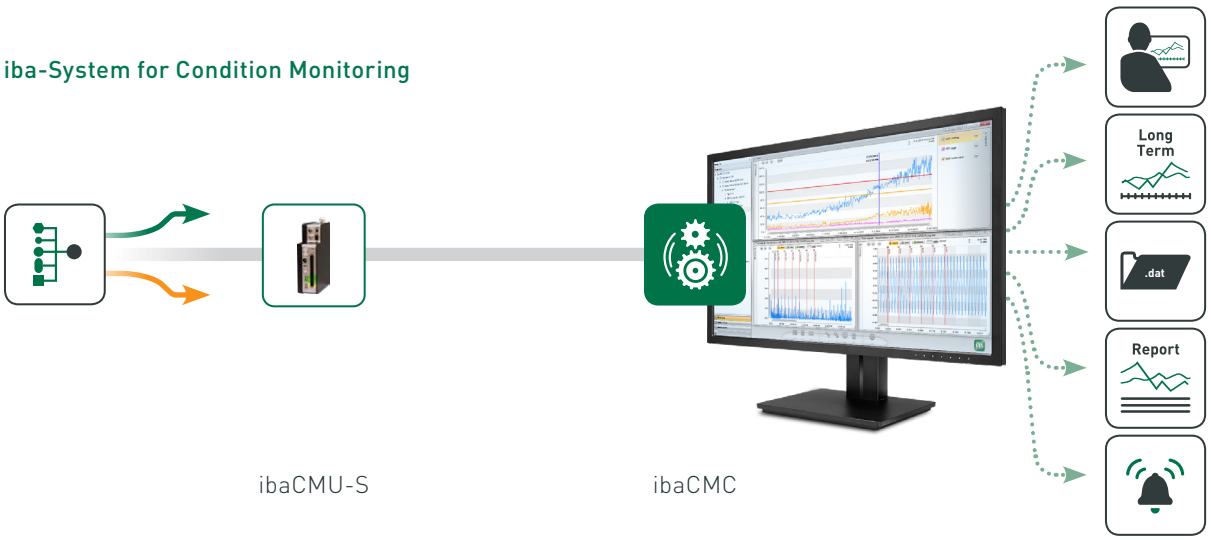
Beside the opportunity of a long-term analysis, ibaCMC offers more functions like a convenient configuration surface with a comprehensible components database, intelligent alarming, a powerful reporting system and much more.

Detailed information about ibaCMC at page 6

At a glance

- With ibaCMC and ibaCMU-S
- Central tool for vibration analysts and mechanical maintenance
- Periodical measurements (snapshots)
- Long-term trending of the calculated characteristic values
- Virtual trending
- Component-specific analysis
- Alarm messages for defined states
- Reporting function

iba-System for Condition Monitoring



ibaCMC

The Condition Monitoring Center ibaCMC is a high end web-based desktop application for trending, alarming and reporting tasks. The only software needed on the client side is a web browser.

Role-based user management
Different user roles (e.g. Administrator, signal analyst, electrical maintenance personnel, responsible plant engineer, etc.) demand different functionalities and views of different data. The detailed user configuration module provides an extensive toolbox for this task.

Easy configuration
ibaCMC provides a built in component library, which can be used to setup the plant configuration hierarchically, quickly and easily by using the provided drag & drop functionality.

The hardware configuration module allows the flexible configuration of the ibaCMU devices. Slow data, such as temperatures, can be coupled in via WAGO terminals. The connection to the ibaCMU-S is made via the ibaNet-750 connection with fiber optics. The configuration can be downloaded to the ibaCMU system directly, which will automatically perform a reboot, to apply the new configuration.

Trend view
The trending module provides all the well known functions like zooming, multiple trends in the same view, cursors, navigator bar and many more. Referring to the time axis detailed analysis of time signals, FFT and envelope FFT can be carried out. The auto-reload function updates the views automatically when the trend cursor is moved.

Installation possibilities
ibaCMC can be operated in several ways. The traditional way is installation on dedicated server hardware. However, it can also be seamlessly integrated in a virtual environment (e.g. VMware® ESX™). It therefore can be operated in an electrical room near the plant, in the IT department or it can even be hosted at an external service provider. Because the configuration of a condition monitoring system, the selection and installation of the sensors and the interpretation of results require solid knowledge in the field of vibration analysis, we recommend the integration of the system through a qualified supplier or together with support services (consulting, training, support).

At a glance

- Analysis and configuration backend for ibaCMUs
- Comfortable database driven trend analysis
- High end web-based desktop application
- Extensive mechanical component library
- Alarming and reporting module (e-mail)
- User and group management module
- Support of multiple trends, zooming, auto-reload, navigation bar

Configuration, trends of characteristic values and display of raw data

Hierarchical system configuration with status indication

Long-term trends of calculated characteristic values

Display of raw data and detailed analysis results

Raw data and correlated trend of a damage characteristic value

When the vibration signals are correlated to process signals, the quality of trending and alarming will increase significantly.

False alarm
Example of "virtual trending:" The fault indicators for bearings or gearing derived exclusively from the frequency spectrum or envelope spectrum are, in part, strongly influenced by environmental conditions. This leads to false alarms, see here.

ibaCMU-S

With the modular hardware concept, the Condition Monitoring solution can be adapted optimally to different requirements. A web-based operating concept allows simple and user-friendly configuration and visualization.

Modular concept

ibaCMU-S forms the measurement technology heart of the system. The modular concept is based on ibaCMU-S as central unit, which has 8 digital inputs, and can be extended by up to 4 input/output modules.

I/O modules are available for vibration measurements according to IEPE standard as well as analog inputs and digital outputs. Various analog input modules are suited for current and voltage signals of different signal ranges.

ibaCMU-S and the I/O modules are plugged on a backplane panel with module rack, that also serves for the voltage supply of the I/O modules.

Calculation results and raw data are stored together and are the basis for further analyses. Up to 32 vibration signals can be processed per ibaCMU-S.

At a glance

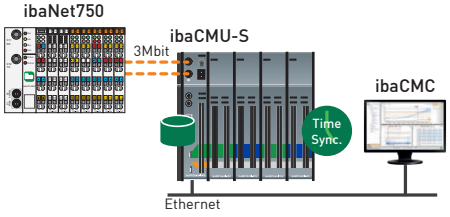
- Modular Condition Monitoring Unit (CMU) with integrated calculation of CM values
- Factory-wide solution with decentralized CMUs and central ibaCMC for configuration, long-term trends and alarming
- All CMUs provide identical complex functions for spectrum analyses, that are configured individually for the measurement location and the part of the plant that is to be monitored
- Configuration with ibaCMC
- Optional acquisition of raw data with ibaPDA via FO outputs
- FO and Ethernet interface
- Data storage in the device (110 GB SSD)

Web-based configuration

A web interface is available on the central unit, which offers extensive diagnostic options. In addition, various tests or a restart can be carried out. The actual system configuration is done with ibaCMC. The system to be monitored is configured here, analyses are determined and alarm functions and reporting are defined.

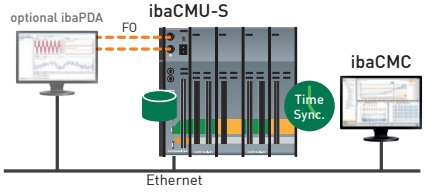
ibaCMU-S with ibaCMC

- Central monitoring of production systems with ibaCMC and decentralized ibaCMU-S systems.
- I/O extension possible via ibaNet750 (3Mbit ibaNet)

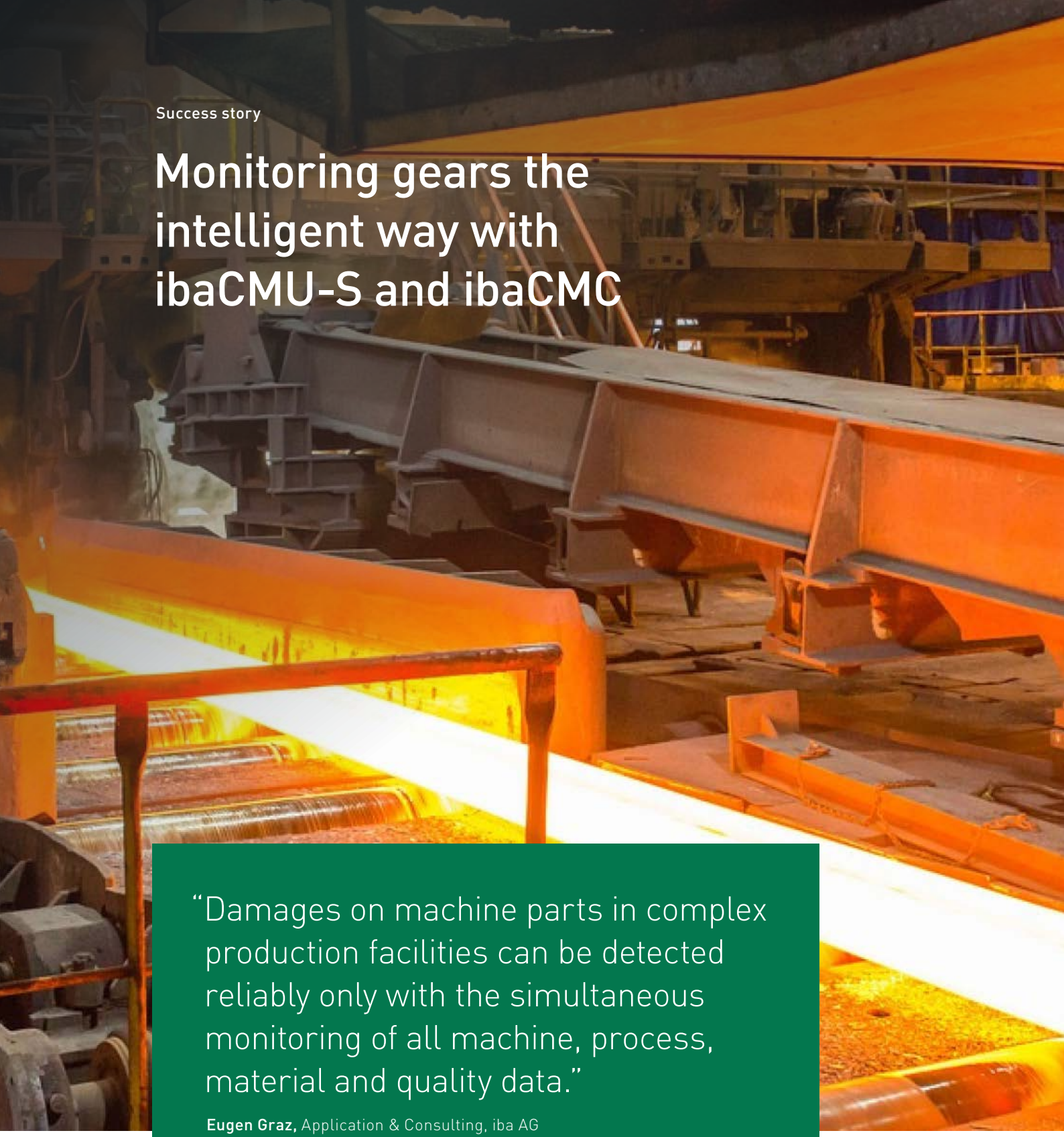


Monitoring the whole plant with ibaPDA, ibaCMU-S and ibaCMC

- Monitoring in the context of a complex plant
- Central acquisition of all relevant machine, process, material and quality data.



Technical data	
Processor unit	
Processor	1.6 GHz atomic processor, single CPU
Operating system	Windows CE® 5.0
Main memory	512 MB
Flash memory	Solid-State-Drive 110 GB
RAM memory	RAM-Drive 128 MB
Clock (RTC)	Unbuffered; optional external buffering, synchronization by DCF77 (digital input) or NTP
Interfaces	
ibaNet	32Mbit Flex, 3Mbit FO cable 50/125 µm and 62.5/125 µm ST
Ethernet	10/100 Mbit/s
USB	for service purposes only
Digital inputs	
Number	8
Version	Electrically isolated, protected against reverse polarity, single ended
Input signal range nominal voltage Max. input voltage	 DC 24 V ±60 V permanent
Signal range log. 0 Signal range log. 1	> -6 V; < +6 V < -10 V; > +10 V
Input current	1 mA, constant
Debounce filter	Optional: 4 different operating modes
Sample rate	Max. 40 kHz, can be chosen freely
Delay	Typical 10 µs
Electrical isolation Channel-channel Channel-housing	 2.5 kV AC 2.5 kV AC
Connection technology	16-pin terminal block, clamp-type terminal (0.2 mm^2 to 2.5 mm^2), screw connection, included in delivery
Power supply, indicators	
Voltage supply	DC 24 V, ±10 % not stabilized 1 A (without I/O modules), 3 A (with I/O modules)
Power consumption	Up to 20 W
Displays	4 LEDs for operating status of the device 8 LEDs for state of the digital inputs 4 LEDs for CM applications
Certification	
Approval/standards	EMC: EN 61326-1 FCC part 15 class A
Supported modules	ibaMS8xIEPE, ibaMS16xAI-10V, ibaMS16xAI-24V, ibaMS16xAI-20mA, ibaMS16xDO-2A, ibaMS32xDO-24V



Success story

Monitoring gears the intelligent way with ibaCMU-S and ibaCMC

> "Damages on machine parts in complex production facilities can be detected reliably only with the simultaneous monitoring of all machine, process, material and quality data."
>
> **Eugen Graz,** Application & Consulting, iba AG

Significant savings can be made with preventive maintenance using sensor-based Condition Monitoring. This is why Condition Monitoring is getting more and more importance in major industrial plants over the last few years.

First indications of upcoming damages can be detected by acquiring and analyzing vibrations of mechanical components, before these damages might lead to unscheduled plant downtimes and related production losses.

Detecting damages on bearings in a rolling mill early on in the process, was the main objective of this project, as in case of an unplanned failure of a powertrain, the whole production unit would be down. The implemented system can perform detailed analyses of complex plants in order to create reliable information about the state of wear and tear.

The technology

Due to the implemented Condition Monitoring System (CMS), worn components can be exchanged during the regular maintenance cycles and consequential damages by defective components and unplanned plant downtimes can be prevented. For this purpose, the system analyzes vibration signals, searches for characteristic damage patterns and calculates the current damage level based on these data.

In the production plant, shaft speed, torques and other process values of the rolling stands are acquired with iba components and can be set into relation to the vibration data. Thus, the predictions can be improved significantly, as process-induced vibrations can be set into relation to the production behavior.

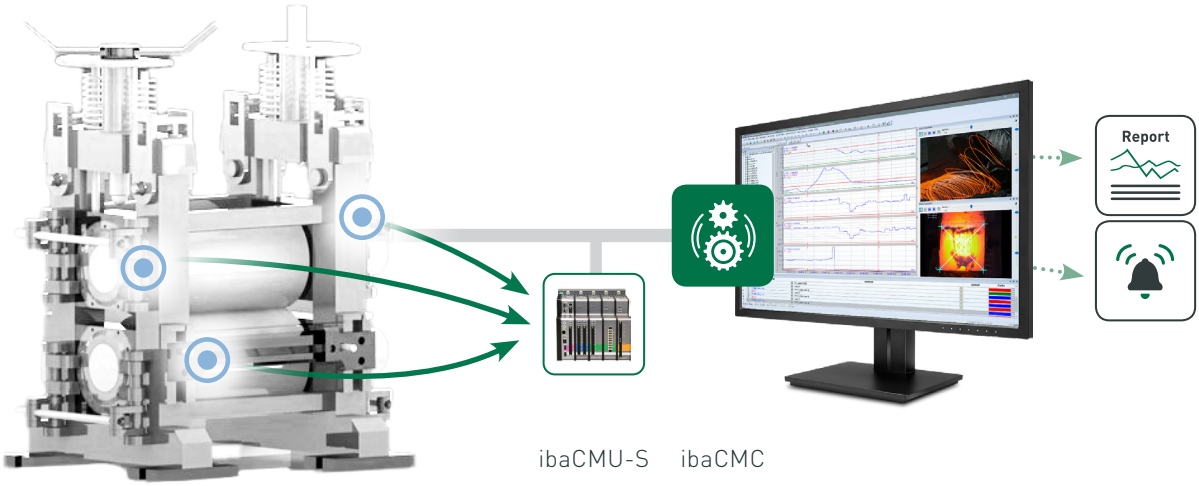
iba products

The iba modular system with ibaCMU-S as central processing unit for acquiring and processing data is the core element of this solution. Being a local unit, the system reads the vibrational sensors of the gears using analog input modules for IEPE sensors that have been especially developed for CM applications.

The web-based ibaCMC Condition Monitoring Center reads the locally stored measurement data of the decentralized ibaCMU-S systems, compares the data to the predefined limit values and sends an alarm e-mail when limit values are exceeded.

Due to the correlation of the process data and the comparison to historical data, convincing trend views of the long-term behavior can be created.
In case of a damage, every gear component generates a characteristic disturbing vibration due to its mechanical properties. Therefore, damages on the components can be identified by specifically defined frequency bands. Hence, false alarms are being prevented and a predictive maintenance becomes possible.

- Preventing plant downtimes with Condition Monitoring as an early warning system
- Minimizes the downtimes of production plants
- Automatic alarm when limit values are exceeded
- Easy integration in existing iba systems



Real Time Vibration Monitoring

Online monitoring: Optimizing processes, increasing product quality

ibaInSpectra is an integrated technology module of the ibaPDA process data acquisition system and processes vibration signals continuously and in real-time. With spectrum and orbit analyses, vibrations can be monitored online and set into relation to other process parameters.

When vibrations become critical, the plant operator is informed via alarm message or email. In addition, a feedback in the plant control can be implemented to automatically adjust the corresponding parameters.

Online monitoring

ibaInSpectra offers different modules for analyzing vibrations online. Also users with little practical experience can do a fast configuration due to the preconfigured calculations. For experts in the field of vibrations, there is a freely configurable Expert module that allows the implementation of a wide spectrum of applications.

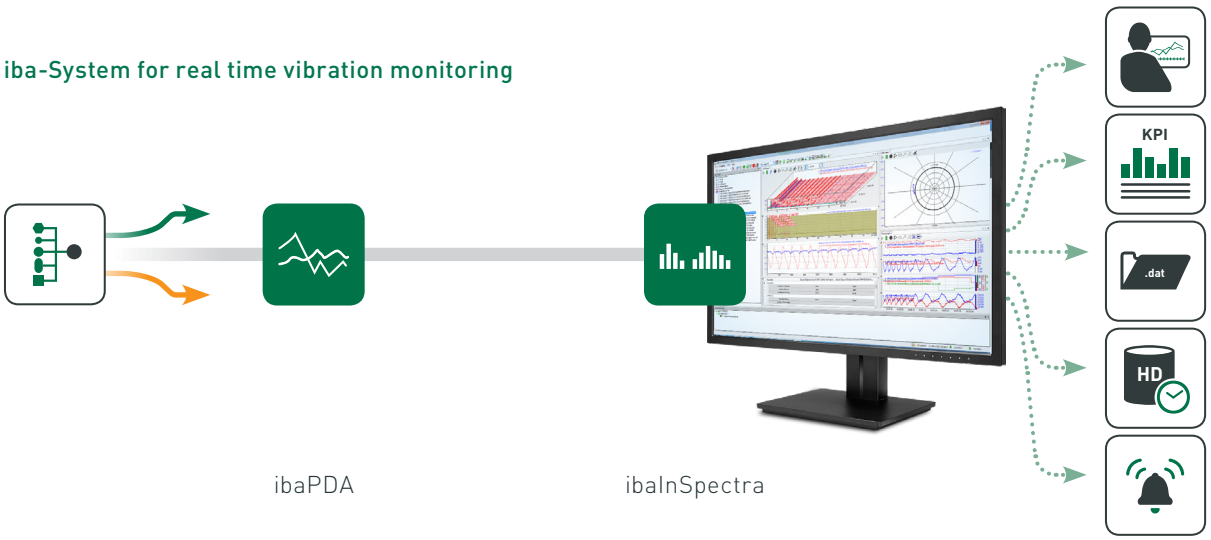
The frequency bands to be monitored can be defined as fixed or depending on process variables and checked to see if they exceed limits. Shaft motions can be monitored online using the Orbit module.

Detailed information about ibaInSpectra at page 14

At a glance

- With ibaPDA and ibaInSpectra
- Control for the operator of the plant
- Continuous monitoring of vibrations
- Freely configurable orbit monitoring
- Freely configurable frequency band monitoring
- Real-time alarm
- Feedback to the control system
- Visualization of the process state in real time

iba-System for real time vibration monitoring



ibaPDA ibaInSpectra

ibaInSpectra

With ibaInSpectra, any vibrations are monitored continuously and possible error sources can be detected in an early stage. As ibaInSpectra is integrated ibaPDA, not only mere vibration analyses can be performed, but also possible relations between vibrational effects and process behavior can immediately be detected.

Open and versatile

In contrast to many other vibration monitoring systems, ibaInSpectra is not a manufacturer-specific system or limited to individual machines, but rather uses the wide connectivity of iba products. Thus, it is perfectly made for the use in heterogeneous automation structures, that are characterized by a great number of different technical disciplines and controller types.

Due to the smooth integration in ibaPDA, vibrational measurement data as well as other machine, process, material and quality data can be acquired centrally and related to each other. Hence, besides the pure vibration analysis of a single machine, also possible effects of the vibrations on the process stability and product quality can be detected.

Real-time analysis

With ibaInSpectra, the sensors can be monitored time-synchronously and continuously and the current frequency analyses can be displayed in real time. ibaInSpectra thus differs from condition monitoring systems, which are designed for long-term trends and that often only analyze vibration sensors briefly at intervals of hours or days. Negative trends as well as significant correlations can be detected early in the process. Critical conditions or exceeded limit values can be signaled immediately, which contributes significantly to the protection of man, machine and material. Moreover, process parameters that influence the vibrational behavior, can be adapted automatically on-line.

At a glance

- Technology module for ibaPDA and ibaAnalyzer
- Real-time analysis of vibrations
- Wide connectivity
- Comprehensive configuration options
- Calculation profiles for multiple usage
- Customized visualization
- Alarming in case of exceeded limit values
- Correlation of vibration and process data
- Expert modules for frequency spectrum and orbit monitoring

Flexible configuration

Designed as an integrated technology module of ibaPDA, ibaInSpectra serves to monitor vibrations. ibaInSpectra provides different modules, which are configured in the I/O manager by ibaPDA.

ibaInSpectra modules

The expert module offers the most diverse parameterization options for the frequency band analysis and is the preferred tool for vibration experts.

Detailed information about the Expert module can be found at page 16

The ibaInSpectra auto-adapting module automatically learns spectra for different process conditions and uses this as a reference to detect changes in the spectrum over time.

Detailed information about the auto-adapting module can be found at page 18

The fan module is used to monitor fans and calculates special indicators for the state of fans.

The orbit module is used to monitor and analyze the shaft motion, for example of plain bearings.

Detailed information about the Orbit module can be found at page 20

Operation and visualization

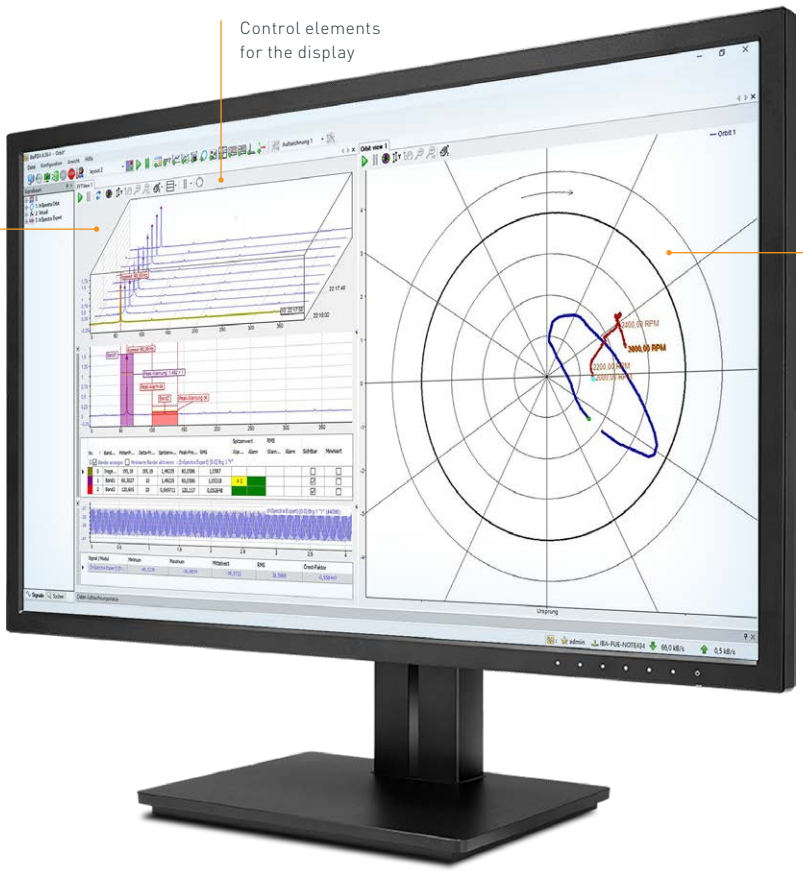
ibaInSpectra modules have an own branch in the ibaPDA signal tree. For the display, just a suitable view needs to be opened and the ibaInSpectra module has to be dragged in by means of drag & drop. The views offer various display options such as waterfall, contour, orbit view, etc. and can be customized as required.

Consistency up to offline analysis

When recording with ibaPDA, the ibaInSpectra modules are stored completely with all the calculated characteristic values in the measured data file. In ibaAnalyzer, all modules are available in the signal tree and the determined characteristic values can be dragged via drag & drop into the trend view or used for other calculations.

With the new product ibaAnalyzer-InSpectra, module configurations can also be exchanged between ibaPDA and ibaAnalyzer. It is now possible to offline configure and validate the monitoring modules on the basis of recorded data without interfering with the production system.

Example for FFT and orbit view



Online monitoring of vibrations

The ibaInSpectra Expert module monitors and analyzes vibrations in the frequency spectrum, which was generated using an FFT analysis. It can be used for a wide range of applications thanks to the high level of flexibility and versatility of the module.

Versatile module for individual vibration analysis

In the expert module, the frequency bands to be monitored can be freely defined, both statically as well as dynamically depending on other measurands. The following parameters are determined for each frequency band as a result of the analysis:

- Peak
- RMS (square average)
- Peak frequency

Freely configurable characteristic values can be calculated based on these parameters. In addition, it is possible to define two limits (warning, alarm) for characteristic values or individual band parameters. In addition to the values from the frequency domain, additional values are determined in the signal's time domain, such as minimum, maximum, average, RMS or crest. The calculations for the analysis can be individually adjusted on many planes by the user or saved as profiles. In particular, the sensor type, type of spectrum and FFT calculation parameters, such as the number of samples, window shape or overlapping factor, can be set. Different methods of averaging are also available, such as the option of detrending in order to compensate for a slow drift of the measured value. Defined profiles can be saved and used multiple times.

Order analysis and envelope calculation

In the calculation profile of the ibaInSpectra Expert module, the user can select a speed signal for re-sampling the input signal depending on the rotation speed. This speed signal can be a pulse train, a pulse counter or an absolute speed value. With resampling, the order analysis for changing speeds is displayed in a much more comprehensive way than with rescaling the x-axis. Moreover, signals can be pre-processed with the ibaInSpectra Expert module. Thus, the vibration signals can be filtered and mathematical precalculations can be done. In the process, an envelope calculation with freely configurable bandpass filter as a signal preprocessing profile is available too. Parameters for calculation profiles are listed in the table on the right.

At a glance

- Comprehensive configuration options
- Calculation profiles for multiple usage
- Customized visualization
- Waterfall display, single spectrum or contour plot
- Calculation of combined characteristic values
- Display of frequency bands and characteristic values
- Alarming in case of exceeded limit values
- Correlation of vibration and process data
- Order and envelope spectrum

Alert and alarm

When configuring the alert and alarm limit values, the ibaInSpectra Expert module automatically supplies analog or digital signals which are activated as soon as the limit values are exceeded. Via the output interfaces of ibaPDA, these signals can be made available to other systems for alerting or interventions in the process control.

Parameters for calculation profiles	
Sensor type	Displacement, speed, acceleration
Spectrum type	Displacement, speed, acceleration
Speed type (optional)	Pulse train, pulse counter, absolute rotation speed
Order analysis	Number of samples per revolution
Number of samples	up to 524288
Number of lines	up to 204800 (depending on the number of samples)
Overlap	0 to 95%
Suppress DC	yes/no
Drift compensation	yes/no
Window type	Bartlett, Blackman, Blackman-Harris, Hamming, Hanning, Rectangular, Flattop
Normalization	yes/no
Method	Magnitude/Power
Averaging type for frequency ranges	Linear, exponential, peak hold

Configuration of bands and characteristic values

Automatically learn spectral analysis

The auto-adapting module can be used to detect damage to machines, gearboxes and motors as well as quality-related changes in process vibrations already at a very early stage. The self-learning InSpectra module offers optimal protection for systems through automatic monitoring in real time using learned reference values.

Detecting damage at an early stage

The auto-adapting module is able to use a series of spectra to learn what the ideal spectrum should look like. The so-called reference spectrum can be learned for various process states, which, for example, relate to different speeds, materials or load areas, etc.

Since ibaInSpectra is seamlessly integrated into ibaPDA, the full ibaPDA connectivity is available to acquire all possible process signals in a system and to be used to define the states.

Comparing with the ideal spectrum and the quantification of the deviation allows the end user to detect changes in process behavior at a particularly early stage before quality issues occur. The auto-adapting module also identifies the areas with the biggest deviations.

Learning and monitoring

Instead of having to manually configure a frequency analysis for certain ranges, all ranges of the spectrum are considered in the auto-adapting module. In the process, the spectrum can be individually divided into any number of ranges. In the learning phase, characteristic values are calculated and taught in across all ranges of the spectrum and a reference spectrum is determined from this. In the monitoring phase, the auto-adapting monitoring compares the current spectrum with the reference spectrum. Since the auto-adapting module is based on the ibaInSpectra Expert module, it offers the same extensive options for configuring FFT calculation parameters in profiles and signal pre-processing.

Permitted deviations can be configured individually. For alerts and alarms, percentage limits can be defined that relate to a maximum or average reference spectrum.

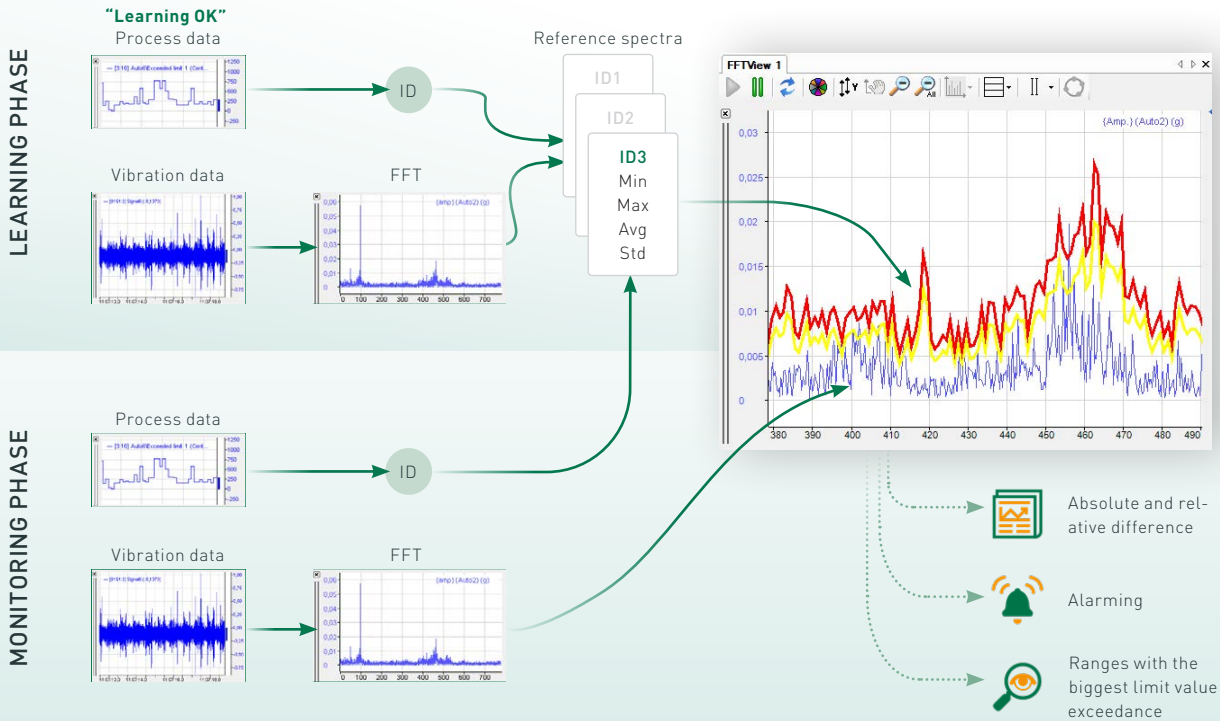
Convincing characteristic values

The auto-adapting module calculates meaningful characteristic values for every state:

- Absolute delta: Total difference between the actual spectrum and the threshold values from the reference spectrum.
- Relative delta: The relative percentage difference between the actual spectrum and the threshold values from the reference spectrum.
- Center frequency, relative difference and peak value for ranges in which the biggest differences occur between the actual and reference spectrum.

At a glance

- Self-learning InSpectra module for spectral analysis
- Reference spectra for various process conditions
- Analysis across the entire spectrum
- Automatic learning of reference values
- Individual definition of warning and alarm limits
- Online visualization in real time
- Early detection of changes and damage



Example of monitoring with the ibaInSpectra Auto-Adapting module

Signal tree with calculated characteristic values and trends of the spectra difference

Visualization of the current spectrum (blue) and the reference spectra of the warning and alarm threshold (yellow and red) in the FFT view

Real time visualization of the spectra as an individual spectrum, waterfall or contour view

Time gradient of difference to the learned reference spectra as an absolute and relative value

Management and adjustment of the learned reference spectra for the different process conditions

Monitoring the shaft motion

The ibaInSpectra Orbit module can be used to monitor the shaft motion relative to bearing housing and therefore allows a reliable monitoring and evaluation of the machine condition. For a stable calculation of the parameters, even at different speeds, the input signals are sampled relative to speed.

Calculation of speed-dependent characteristic values
This ensures not only reliable results for all conditions but also allows an averaging of the orbit over several revolutions.

An average value can be calculated (linearly) or the maximum values of the corresponding rotation angle are evaluated (peak hold).

Characteristic values calculated by the ibaInSpectra Orbit module

- Orbit counter: Number of calculated orbits
- X/Y: Current shaft position
- Centerline X/Y: Position of the shaft center
- Peak to Peak max: S(p-p)max, maximum distance between two points in the orbit
- Peak to peak max angle: Angle of the S(p-p)max
- Peak to peak max shaft angle: Rotation angle of the shaft to which S(p-p)max occurs relative to the phase reference
- Eccentricity: Eccentricity of the shaft
- Distance to clearance: Minimum distance of the shaft to the clearance circle (bearing shell)
- And others

Better insight thanks to a flexible visualization
The orbit view offers various possibilities to adjust the visualization of the shaft motion individually. So the shaft motion can be visualized including phase reference. In addition, the movement history of the shaft center can be displayed over a time period.

Another option is e.g. to display different acceleration levels during the start-up of the machine. To improve the understanding of the movement, the clearance diameter, rotation direction, sensor positions and the position of the phase reference can be displayed.

Offline detailed analysis with playback function
For a detailed offline analysis the recorded data can be opened together with the calculation profiles in ibaAnalyzer-InSpectra. Shaft motions can be analyzed subsequently and can be compared with other process data to recognize correlations. Additionally, the behavior can be reproduced at certain points of time, using the playback function.

At a glance

- Calculation of characteristic values for validation and monitoring
- Display of one or several shaft motions (orbit)
- Display of the shaft center motion (centerline)
- Speed-dependent resampling
- Visualization of acceleration levels
- Calculation profiles for multiple usage
- Customized visualization
- Display of the phase reference
- Averaging over several rotations (linear or peak hold)

Characteristic values of the Orbit module	
Orbit counter	Displacement, speed, acceleration
X/Y	Current shaft position in the coordinate system
Centerline X/Y	Center position of the shaft center per calculation in the coordinate system
Peak to Peak max	Peak to peak maximum value (S(p-p)max), maximum distance between two points in the orbit
Peak to peak max angle:	Angle at which the S(p-p)max occurs
Peak to peak max shaft angle:	Rotation angle of the shaft to which S(p-p) max occurs relatively to the key phasor
Eccentricity	Eccentricity of the shaft
Distance to clearance	Minimum distance of the shaft to the clearance circle

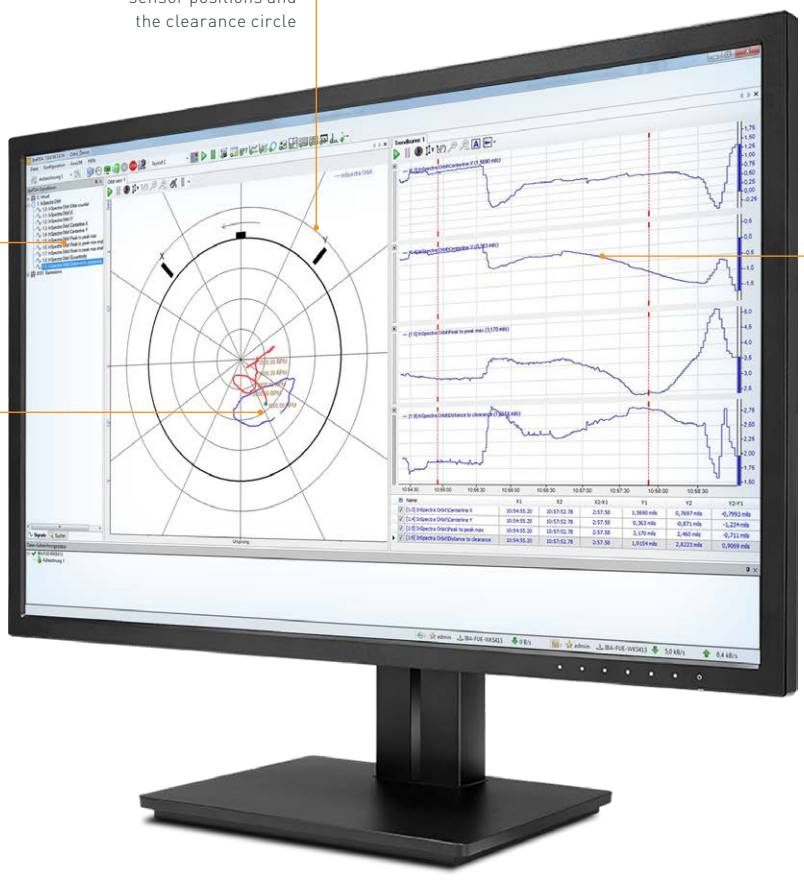
Orbit appearance in the PDA client

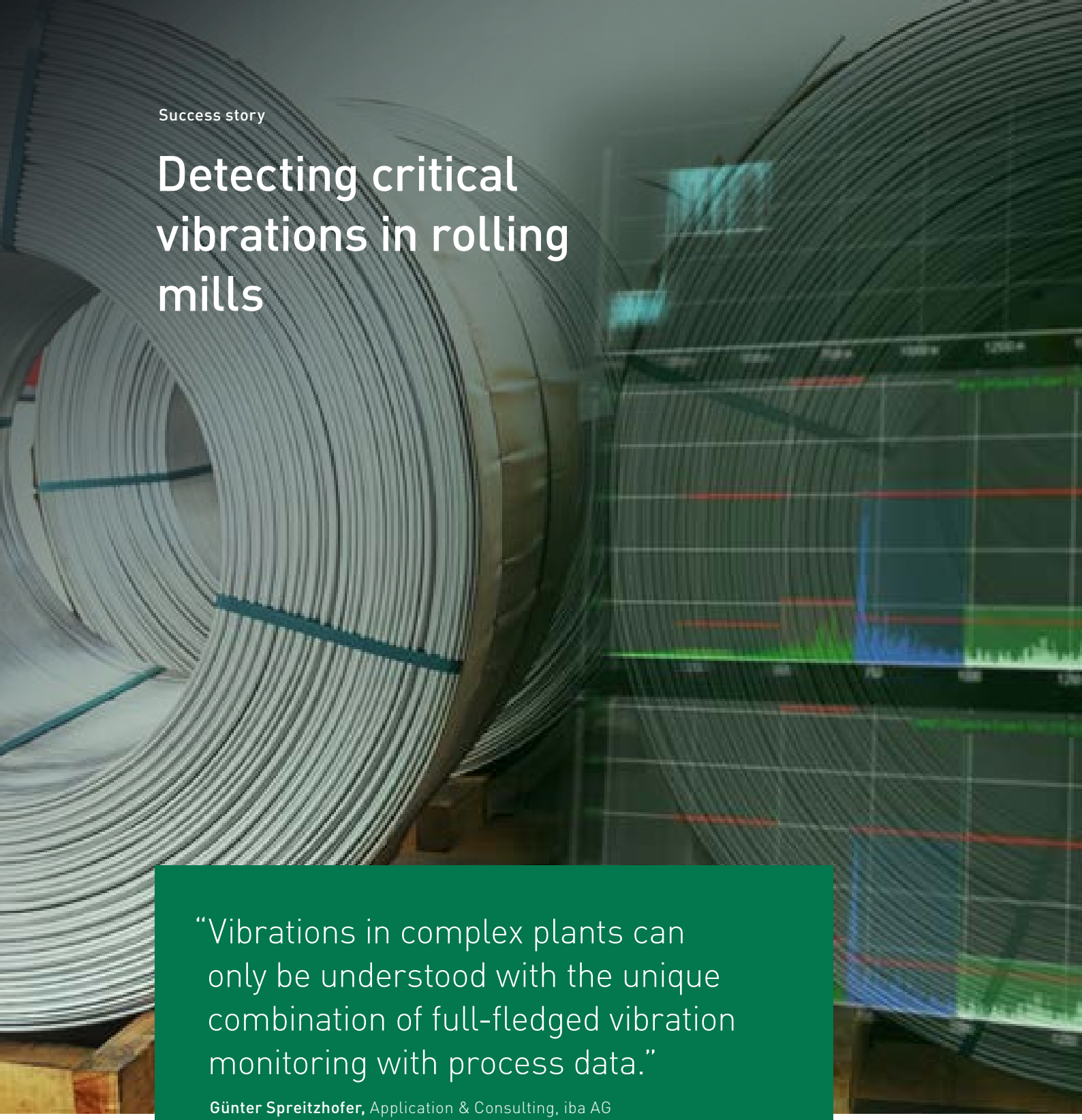
Visualization of the sensor positions and the clearance circle

Time gradient of the calculated characteristic values, such as: peak to peak maximum value, eccentricity and distance to the clearance circle

Signal tree with calculated characteristic values and results of the orbit analysis

Real time visualization of the shaft motion, blank-bright visualization of the key phasor, gradient of the centerline and speed levels for run-up and run-down





Success story

Detecting critical vibrations in rolling mills

> "Vibrations in complex plants can only be understood with the unique combination of full-fledged vibration monitoring with process data."
>
> **Günter Spreitzhofer,** Application & Consulting, iba AG

In rolling mills, many vibrations may occur that have negative effects on the life cycle and the state of the plant, but also on product quality. If wear and defects are detected early enough, appropriate counter-measures can be initiated for reducing waste and downtimes.

Anyway, the user has to know exactly the vibration behavior of the plant and set it into relation to other process data from the plant.

In a cold rolling mill, the process data recording system ibaPDA has been used for process data analysis, but the vibration measurement data was evaluated separately. With ibaInSpectra as add-on to the ibaPDA system, the acquired vibration signals can be analyzed within defined frequency ranges. Simultaneously, processes with all machine, material and quality data can be monitored.

The technology

Cold rolling mills show a complex vibration behavior, consisting of natural vibrations of the plant mechanics as well as excitations from the drive or bearings but also vibrations caused by defects. The aim of the monitoring is to detect vibrations that are caused by external excitation or faults. In this particular case, acceleration sensors on the chocks which serve as bearing for the rolls give insight into the vibration behavior of the whole stand. During normal operation, the natural vibrations of the stand are in the low-frequency range. High-frequency vibrations are an indicator for external excitation. With ibaInSpectra, these vibrations can be assigned to individual components.

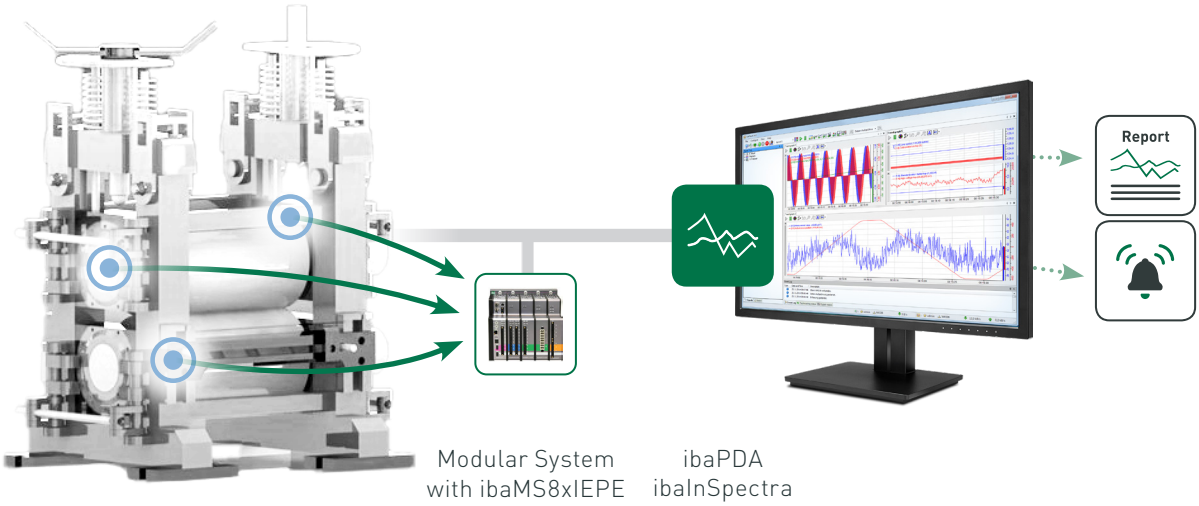
iba products

The ibaMS8xIEPE samples the values of the vibration sensors at a rate of up to 40 kHz with 16-fold oversampling and make these values available to the ibaPDA system in digital form. With ibaInSpectra Expert modules, a freely configurable frequency band analysis in real time can be applied to the data. For every frequency band, characteristic values like peak, RMS and peak frequency can be determined.

The system acquires data from the plant, such as speed, rolling force, torque, etc. time synchronously. The characteristic values of the frequency band and the process data can be used to draw conclusions about the cause of the undesired vibration.

ibaInSpectra can vary vibration-relevant process parameters online using the integrated alarm function, in order to keep the vibrations within reasonable limits. Additionally, the measurement data are visualized in real time with the ibaQPanel on the control stand of the control system. Thus, the operator can initiate manual interventions in a targeted way.

- Automatic alarm in real time when limit values are exceeded
- Minimizing false alarms by taking process parameters into consideration
- Easy integration in the existing iba system
- Conclusions about possible causes



Modular System with ibaMS8xIEPE

ibaPDA ibaInSpectra

Offline Vibration Analysis

Intelligent tools for offline analysis

The offline analysis tool ibaAnalyzer-InSpectra makes it possible to create meaningful analyses from the recorded vibration data.

ibaAnalyzer-InSpectra offers the functionality of ibaInSpectra for vibration monitoring offline in ibaAnalyzer. Analysis configurations can first be designed and tested offline within ibaAnalyzer and transferred to ibaPDA for real time vibration monitoring. It can also be used to verify existing ibaInSpectra installations to help tune the online calculations.

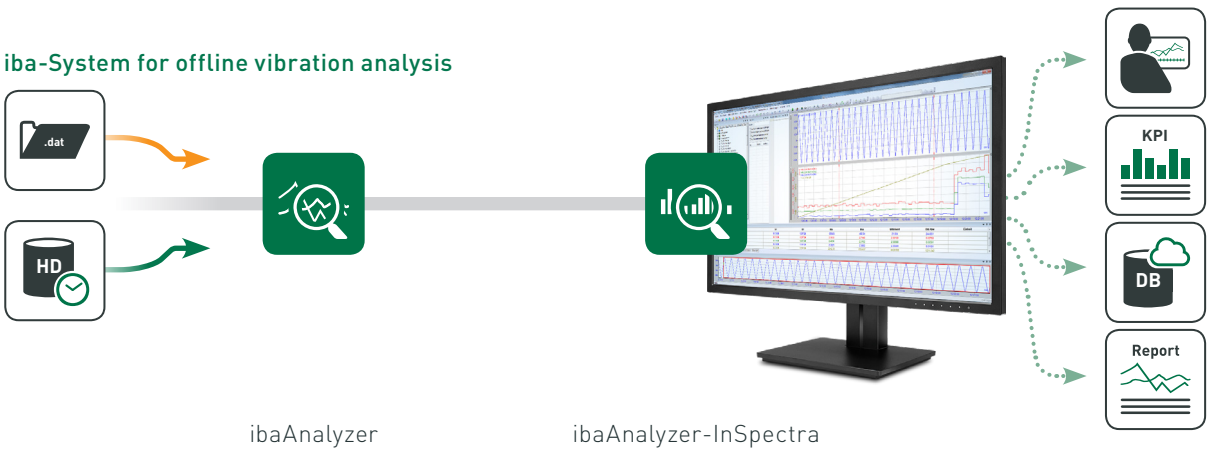
Due to the integration in ibaAnalyzer, it is very easily possible to use and compare all recorded process parameters for the analysis. As a result, unique possibilities are offered to combine process and vibration analysis and to view the problem comprehensively.

Detailed information about ibaAnalyzer-InSpectra can be found at page 28

At a glance

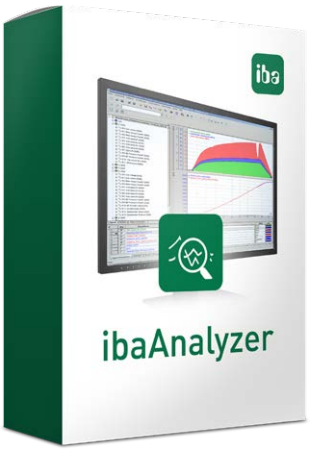
- Machinery diagnosis for troubleshooting, product development and predictive maintenance
- Offline configuration of the InSpectra profiles with ibaAnalyzer-InSpectra
- Fine-tuning of vibration and orbit monitoring offline
- Validation of alerts and alarms

iba-System for offline vibration analysis



ibaAnalyzer ibaAnalyzer-InSpectra

ibaAnalyzer



Within the iba system, ibaAnalyzer is the key element in the field of data analysis. ibaAnalyzer is a very powerful tool for analyzing measurement data efficiently and without generating additional costs as well as for deriving information from these analyses. Analysis procedures can be created flexibly and adapted individually, in a way that different users get the right analysis for their special purposes.

Analyzing and evaluating without additional costs

ibaAnalyzer is characterized by broad functionalities for analyzing and evaluating. The application offers an intuitive operation along with the complex scope of functions.

The license for ibaAnalyzer for analyzing measurement files which have been generated with the iba system, is free of charge.

Stay flexible and high-performing

Analysis rules can be created flexibly and adapted individually, in a way that different users get the right analyses for their purposes, e.g. for analyzing failures, but also for performing long term analyses in order to evaluate and optimize processes.

The wide-ranging analysis features comprise the automatic calculating of specific characteristic values and static values, but also product-related quality data that can be used for a superordinate quality management system.

Moreover, by means of powerful mathematical and technological functions, signals can be combined, calculated or set into relation to the raw values. Further features amongst others are: Filter designer, macro editor, time- or length based display, X/Y appearance.

Automatized generation of reports

The integrated report generator is a powerful tool that grants a flexible creation of creating individual reports. With the report generator, efficient options for creating templates are available.

At a glance

- Extensive analysis possibilities
- Intuitive operation with smart docking windows and drag & drop functions
- Combination of data originating from different measuring processes or data sources
- Powerful mathematical and technological functions for combining, calculating and creating virtual signals
- Powerful graphic digital filter designer
- Reuse of analyses
- Versatile markers for measuring signals
- Macro-function for protecting know-how

ibaAnalyzer	
Function	**Detail**
Interactive analysis of a measurement file	Visualization of signals, measuring duration, detecting causal dependencies, error analysis
Process data analysis	Open several measurement files simultaneously; compare process behavior
Characteristic value calculation	Linking signals using the mathematical expression editor (virtual signals); creating characteristic values
Extraction in databases	Extraction of characteristic values in databases Extraction of signal data in databases with temporal aggregation (ibaAnalyzer-DB product)
Extraction in measurement files	Export of data in iba measurement files with reduced signal scope or lower temporal resolution (data aggregation) (ibaAnalyzer-File-Extract product)
Export to external formats	Extraction of data in external formats (csv, Parquet, etc.) (ibaAnalyzer-File-Extract product)
Report creation	Create layout once (templates) and create reports with current measurement data

Elements in the ibaAnalyzer view:

Signal tree List of recorded signals and InSpectra modules

Analysis rule The visualization view and definition of virtual signals can be saved as an analysis rule (pdo file). In this way, an analysis can be applied to several measurement files.

Expression editor An expression editor with a very extensive function library is available to create virtual signals

Trend view Visualization of signals for the detailed analysis

Signal definition List of visualized signals. These can be recorded or virtual signals.

ibaAnalyzer-InSpectra

ibaAnalyzer-InSpectra offers the functionality of ibaInSpectra for vibration monitoring offline in ibaAnalyzer. The configuration of the online system can be made offline basing on the acquired data and calculations which can be validated and adjusted subsequently. In addition, ibaAnalyzer allows a detailed analysis of the recorded data for process and machine diagnosis.

Integrated tool environment
ibaInSpectra is an add-on in ibaPDA and offers various options of online monitoring of vibrations and shaft motions. ibaAnalyzer is a powerful analysis tool to analyze recorded data and to recognize causes of problems in faults. With the ibaAnalyzer-InSpectra product, a gap is bridged between ibaPDA and ibaAnalyzer and an integrated tool chain from online monitoring to detailed offline analysis is offered. The two most important modules in this context are the Expert module for the frequency band analysis of vibrations and the Orbit module for the analysis of shaft motions.

Configuration tool for ibaInSpectra
ibaAnalyzer-InSpectra makes it possible to configure calculation rules in the form of profiles offline and to test them on already recorded data. These profiles can be transmitted to ibaInSpectra with the help of export and import functions and used there. Existing calculation profiles from ibaInSpectra can also be transferred to ibaAnalyzer-InSpectra to adapt calculations or adjust limit values.

Validation and offline analysis
With ibaAnalyzer-InSpectra, not only raw signals and calculated characteristic values can be opened in ibaAnalyzer, but also the calculation profiles. Thus it is also possible to carry out the calculations of ibaInSpectra offline. Characteristic values that have triggered an alarm can be validated and the problem can be analyzed offline.

The extensive functions of ibaAnalyzer-InSpectra offer a helpful option here: By changing the analysis rules, the user gets a better view of the information relevant to the problem being considered.

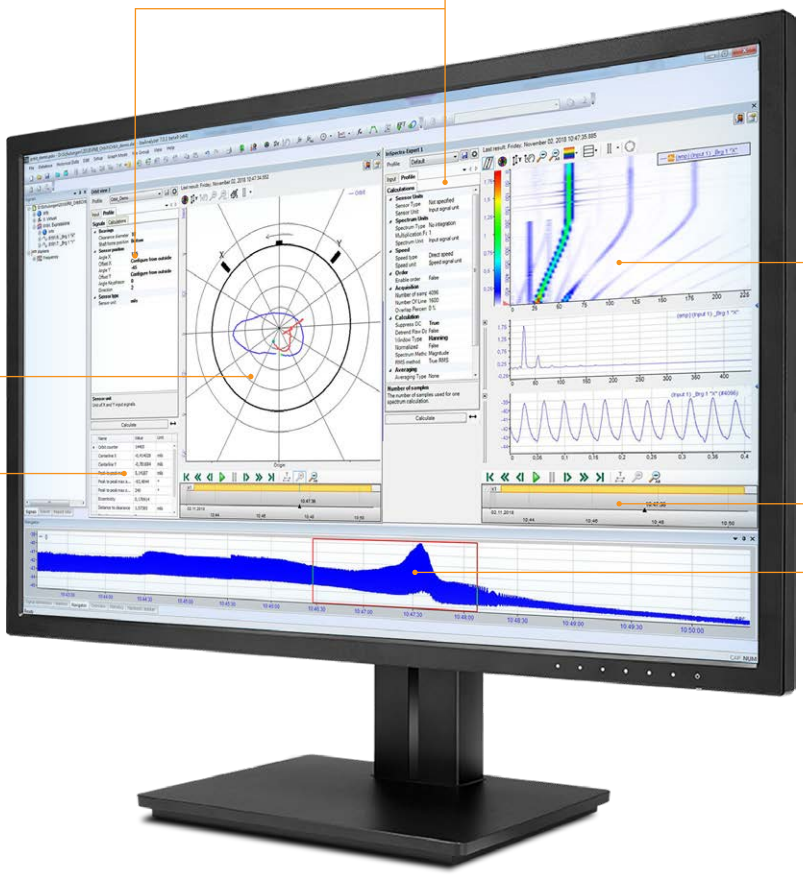
At a glance

- Offline configuration of the ibaInSpectra profiles based on recorded data
- Fine tuning of vibration and orbit monitoring offline
- Validation of alerts and alarms
- Detailed analysis of the process and machine behavior taking into account all process parameters
- Frequency band analysis using the Expert module
- Shaft motion analysis using the Orbit module

Licensing
The InSpectra expert view is available in ibaAnalyzer without additional license. With the ibaAnalyzer-InSpectra+ license, the results of the InSpectra calculations will be available in ibaAnalyzer as signals, can be exported to databases and used for further processing in reports or with ibaDatCoordinator.

ibaAnalyzer-InSpectra modules	
Expert	**Orbit**
Freely configurable frequency band analysis	Analysis of shaft motions
Calculation of statistical characteristic values	Calculations based on rotation angle
Calculation of combined characteristic values of the frequency band analysis	Calculation of characteristic values as per DIN ISO 7919
Detailed and flexible visualization	Extensive visualization of the shaft motion
Order analysis through speed-dependent resampling	Display of speed levels during run-up and run-down measurements
Synchronization and playback of all displays with navigation pane and marker positions	Synchronization and playback of all displays with navigation pane and marker positions

Elements in the ibaAnalyzer-InSpectra view:



Success story

Optimization of a condition monitoring system with ibaInSpectra and ibaAnalyzer-InSpectra

"The unique combination of process and vibration analysis makes it easy for me to understand and analyze the vibration behavior, even with complex processes."

Christian Reinbrecht, Product Manager, iba AG

A Condition Monitoring System (CMS) is supposed to monitor the wear of two motors. The CMS calculates characteristic values at regular intervals under certain measurement conditions, which serve as status indicators for the individual machine components, and records these as a long-term trend.

After a test phase it became apparent that the standard calculations and settings of the CMS did not provide reliable characteristic values for wear detection due to the conditions on site.

This phenomenon now had to be investigated. With the iba tools for vibration analysis, the recorded trends and raw data were therefore analyzed more detailed in order to configure the Condition Monitoring System to deliver reliable characteristic values.

The analysis

In the long-term trends, the characteristic values increased at some points in time by a factor of more than 10. Each characteristic value was affected at different times. A temporal correlation could not be recognized.

However, the representation of the characteristic values as an X/Y diagram in ibaAnalyzer showed clear conspicuities.

The calculated characteristic values were displayed sorted according to the speed at which they were recorded. It could now be seen in the X/Y diagram, that certain characteristic values were increased, especially in specific speed ranges.

Therefore, the raw data of a DAT file were examined more closely for speed-independent frequencies. In fact, a high frequency including two harmonics can be recognized in ibaAnalyzer-InSpectra. Although the cause was found, it was not possible to resolve the problem technically.

The solution

With the help of the marker function in ibaAnalyzer-InSpectra it could be proven that the bands used to calculate the parameters intersect this high frequency or one of the harmonics - exactly in the speed ranges where the characteristic values were exceeded. The measurement conditions and calculation rules of the characteristic values were then optimized in that way that this frequency was no longer within the bands that were used for the calculation of the parameters.

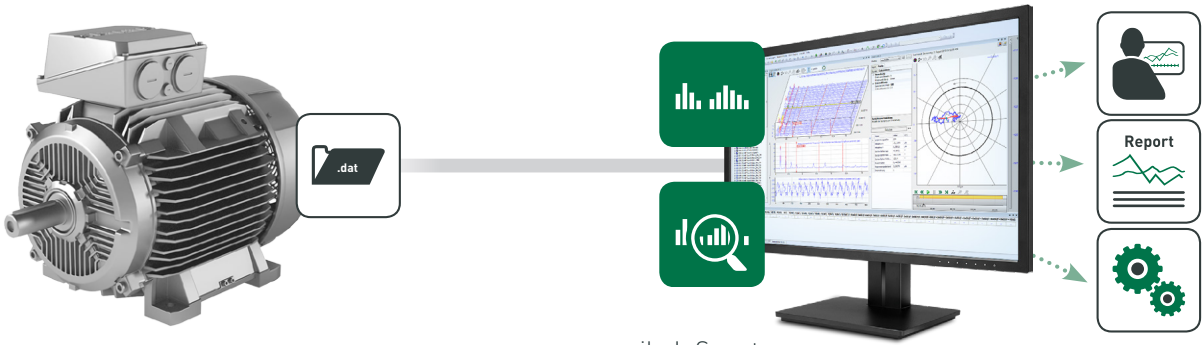
Finally, these adjustments required the alarm thresholds to be checked and reset. In the next step, the current states of the monitored components were therefore analyzed on the basis of the raw data. For a better overview, the speed-independent frequency and its harmonics have been eliminated using the Vold-Kalman filter.

Within the scope of the analysis, an additional insight could be obtained: In the waterfall display without the dominant frequencies, a developing damage was detected on another machine from which a low vibration level had been transferred to the monitored machine.

Finally, it was necessary to determine in which range the characteristic values were to be expected from the new calculations. A simulation with ibaInSpectra based on a playback of the measured data was helpful here. With the help of the simulation, the alarm values could be reliably calculated without a learning phase.

With the configuration customized this way, the Condition Monitoring System is optimally configured for the customer's system. The system now delivers reliable characteristic values and enables the validation of the current status.

- Optimum understanding through combination of process and vibration analysis
- Validation of configurations and alarms from online systems
- Root cause analysis for proactive maintenance
- Automated calculation of characteristic values



ibaInSpectra

ibaAnalyzer -InSpectra

Order information

Software		
Order No.	Name	Description
30.681229	ibaCMC-Ultimate	Condition Monitoring Center
30.681223	ibaInSpectra	ibaPDA license extension, spectrum analysis library, 4 modules
33.010410	ibaAnalyzer-InSpectra+	Offline vibration analysis: trend and output of the InSpectra results in ibaAnalyzer

ibaCMU-S		
Order No.	Name	Description
10.125010	ibaCMU-S	Condition Monitoring Unit CPU, for up to 8 vibration signals
10.125011	ibaCMU-S-upgrade HW 8-to-16	License upgrade for 8 additional vibration signals
10.125012	ibaCMU-S-upgrade HW 8-to-24	License upgrade for 16 additional vibration signals
10.125013	ibaCMU-S-upgrade HW 8-to-32	License upgrade for 24 additional vibration signals
10.125014	ibaCMU-S-upgrade HW 16-to-24	License upgrade for 8 additional vibration signals
10.125015	ibaCMU-S-upgrade HW 16-to-32	License upgrade for 16 additional vibration signals
10.125016	ibaCMU-S-upgrade HW 24-to-32	License upgrade for 8 additional vibration signals

Training		
Order No.	Name	Description
61.000700	Monitoring and analysis of vibration data with ibaInSpectra	2-day advanced course
61.002000	Condition monitoring and diagnostics of machines according to ISO 18436 category I	5-day certification course
61.002001	Condition monitoring and diagnostics of machines according to ISO 18436 category II	5-day certification course

The entire training program can be found at iba-ag.com/training

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